# Light and Lighting

Vol. XLVII.—No. 10
October, 1954

*Published by The Illuminating Engineering Publishing Co., Ltd., on the 1st of each month, at 32, Victoria Street, London, S.W.1. ABBey 7553. Subscription rate 25s. per annum.*

CONTENTS



# Lighting and Productivity

"PRODUCTIVITY" is always topical, and that there is an association between lighting and productivity is more certain than that there is an association between smoking and lung cancer. But whether, in particular cases, certain conditions of lighting yield better productivity than others must be determined by trial, no matter what expectations may be supported by "theoretical" considerations. For efficiently producing many products the conditions required do not have critical values, that is to say, providing the general principles of good lighting are put into effect, it is of little or no consequence whether, e.g., the colour temperature of the illuminant is $x$ instead of the slightly different $y$, or whether the light distribution strictly conforms with a certain specification. However, we need more studies of lighting in relation to productivity, difficult though they are to make in ordinary "field" circumstances. This year artificial lighting has had an unusual role in aiding harvest productivity; not because natural lighting has "let us down," but because inclement weather made it impossible to take advantage of it at the right time. We usually think of productivity in terms of "more of something we want," but lighting can and should be used to *reduce* productivity of such things as spoilt work and accidents.

# Notes and News

## *I.E.S. President, 1954-55*

With the opening of the 1954-55 session of the I.E.S. Mr. E. C. Lennox takes office as president of the Society. He will present his presidential address, entitled "Lighting and Electricity Supply," at the opening meeting to be held at the Royal Institution at 6 p.m. on Tuesday, October 12.

*E. C. Lennox, I.E.S. President,* 1954-55

Mr. Lennox has the distinction of being the first representative of the electricity supply industry to hold this office. It is fitting that this should be so for in the whole of the 40 years that he has spent in the industry he has taken the keenest interest in lighting matters. He joined the staff of the North-Eastern Electric Supply Company in 1914 as a junior engineer and is now manager of the Wear Sub-Area of the North-Eastern Electricity Board. The whole of his career has been concerned with electricity supply and lighting on the north-east coast.

He is a Fellow of the I.E.S. and a founder-member of the Newcastle Centre, of which he is a past-chairman. He is the first member of that Centre to become president. (In passing, it is interesting to note that of the last six presidents of the Society, four have been from the provinces.) He served as a member of the I.E.S. Council from 1948-51 and was a vice-president from 1951-53. He is a member of the I.E.E., before whom he has presented papers, and was president of the Association of Public Lighting Engineers in 1936. Street lighting has been his main connection with lighting and he is a member of the Street Lighting Committee of the British Electrical Development Association, having served as chairman from 1936 until 1948. His interest in lighting is not, however, confined to street lighting—as will no doubt be evident from his presidential address.

It would seem, apart from his obvious qualifications for office, that the appointment of Mr. Lennox as I.E.S. president is a very happy one. Liaison with other bodies concerned with lighting is one of the jobs of the I.E.S., and Mr. Lennox brings with him intimate connections with many such bodies; the importance of the electricity supply industry in the development of lighting cannot be denied, and a closer link with organisations such as the A.P.L.E. and E.D.A. can only be to the advantage of all concerned.

We would congratulate Mr. Lennox on becoming I.E.S. president and wish him every success during his year of office. The duties of president become more onerous each year; the calls upon his time seem to increase year by year, and the new president will have to spend even more time than he does at present in travelling between London and the North. In accepting office Mr. Lennox deserves the fullest support of the Society, which we are quite certain he will receive wherever he goes.

## *I.E.S. Programme*

The recently issued I.E.S. programme of meetings during the new session again contains a wide variety of subjects, both in London and in the provinces. Amongst the names of authors we see a number who have established reputations for giving good lectures and the names of many others who are new and who are introducing new subjects.

The London programme includes the third Trotter-Paterson Memorial Lecture, which is to be given at the Royal Institution on March 9 by the Astronomer Royal, Sir Harold Spencer Jones; the Society is again to be congratulated in securing the services of one of our most eminent scientists for this lecture. Another important item is the meeting at which the entries for the second Dow Prize Competition will be displayed and discussed by the assessors. That this meeting should be held at the Royal Institute of British Architects is a very good thing. It is our impression that architects are taking more interest in lighting than they did a few years ago; this may be due in part to this competition and the co-operation of the R.I.B.A. is very welcome. Only two of the Centres appear to have made a deliberate attempt to attract architects during the session,

though we notice that Mr. Waldram is repeating his paper on studies in interior lighting at a number of the Centres, and we would suggest that every attempt is made to get architects to attend and discuss this paper.

We notice in the London programme the inclusion of the lecture by C. H. Edlin on light and crime detection. This paper started, we believe, in Nottingham, where Mr. Edlin is with the Forensic Science Laboratory, and has since been repeated at several of the Centres; it will make a refreshing change for London members.

A year or two ago the subject of home lighting was discussed in London and a paper on it was given at the recent summer meeting. On both occasions the guillotine procedure had to be applied to the discussion, so that there can be no doubt that the subject is one on which people have plenty to say. The subject comes up again in London on March 29—we wonder what method will be used this time to get everyone arguing. We see that the summer meeting paper given by C. J. Misselbrook and A. H. Young is doing a tour of the Centres.

The session in London ends in May with what promises to be an attractive item, a lecture by Jean Chappat on the illuminated chateaux of France. We have read about these chateaux and published an article on Versailles in a recent issue; few of us, however, have been able to see for ourselves this interesting lighting development which has swept across France during the past two or three years. Jean Chappat has long been a good friend of the I.E.S. and a regular visitor to the summer meetings; his lecture next May should draw a full house.

## *Directory of Manufacturers*

From time to time we receive requests for the names of firms who manufacture various items of lighting equipment. To help us to supply such information we began to compile a list of firms and the items they make. This list has proved very useful, and it occurred to us that it would be equally useful to buyers of lighting equipment. With the assistance of the firms mentioned therein we therefore compiled the Directory of Manufacturers of Lighting Equipment, a copy of which is circulated with each copy of this issue of *Light and Lighting*. As far as we are able to ascertain, the directory at the time of going to press includes the name of every firm in this country manufacturing lighting equipment; there is, however, a first time with everything, and the omission of any firm is unintentional. It is our intention to revise the directory from time to time and to bring it up to date as changes occur.

The directory is, of course, intended for buyers, and we hope that it will prove of value to them and to manufacturers. Copies are circulated without charge to readers of *Light and Lighting*; further copies may be obtained price 1s. 6d.

## *C. & G. Examination Results*

The results of the City and Guilds of London Institute examinations in illuminating engineering which were held earlier this year, are given below :—

*Intermediate Grade*

**First Class.**—C. H. Bedwell, D. Bradshaw, R. Croft, N. B. L. Drapkin, N. Drasco, A. G. Free, Miss J. W. French, N. P. Gripper, J. H. Howard, W. K. Lumsden, B. O. Matthews, B. J. O'Dwyer, M. W. Picton Pegg, K. H. Ragsdale, J. E. Robinson, R. A. Southby, Miss J. L. Stewart, W. J. Walpole.

**Second Class.**—J. R. Arlott, A. R. Bean, P. K. Brighting, J. I. Bryan, S. J. Chasey, J. E. Collins, A. J. Dowling, P. J. Engert, P. Hutchings, G. W. Lawlor, C. J. Martin, M. A. Maloney, R. Monery, W. T. McLarnon, R. E. Percival, Miss E. A. Phillips Tingle, D. H. Rees, W. F. H. Robbins, W. Roberts, M. A. Ryle, D. R. Singer, J. E. Smith, J. Stewart, J. J. Toomey, F. E. Ward.

*Final Grade*

**(Papers 1 and 2)**

**First Class.**—M. D. Bowl, Miss W. M. Godfrey, J. F. Pickup.

**Second Class.**—C. S. Bayliffe, T. B. Coles, A. M. Gummer, G. N. E. Joyce, C. R. Mortimer, S. Pearson.

**(Papers 1 and 3.)**

**First Class.**—W. R. Bradshaw, T. B. Coles, J. F. Roper.

**Second Class.**—R. E. Cavalier, W. R. Gibbon, A. M. Gummer, R. J. Hobson, J. Horswill, N. Man-Siu Kwong, A. Maidman, H. T. Norris, J. F. Pickup, A. G. Wingrove.

The total number of passes is about the same as last year, there being an increase of nearly 50 per cent. in the intermediate grade and a decrease in the final grade. The number of passes during each of the last three years has been about the same in spite of the fact that the number of colleges able to raise sufficient students to justify arranging courses has decreased. Perhaps more students are taking advantage, with success, of the correspondence courses.

During the present session courses are available in London at the Borough and Northampton Polytechnics and at the South-East London Technical College. The only course outside London to our knowledge is at the Technical College, Bradford.

## *Frontispiece*

When we first saw the original of the picture on p. 278 we thought it must be of somewhere like Bruges—it didn't occur to us that it could have been taken in this country. How many places are there, we wonder, that we could exploit in the same way as the Belgians have exploited Bruges and the French their chateaux ?

*The Weavers' Houses, Canterbury.*

# Illuminants for Colour Reproduction and Printing

**In the printing industry illuminants are required not only for technical operations but also for colour matching and control. In this article the technical aspects are outlined with special reference to the desired characteristics of light sources required for colour reproduction.**

By H. M. CARTWRIGHT, F.R.P.S.*

The illuminants required for colour reproduction and printing may be divided into two distinct categories: (a) those essential for technical operations, mostly of a photographic character, in which physical requirements have to be considered, and (b) those for viewing and matching colours, where the considerations are largely subjective. The two categories will be considered under separate headings after the technical operations have been outlined.

### Part I.—Technical Operations

Four major methods of printing are in use; they are letterpress, lithography, photogravure, and collotype. There are also other methods of lesser importance. The techniques are different for each method, but illumination requirements are essentially the same in all cases. Attention will be concentrated on letterpress printing with its associated line and half-tone reproduction. Letterpress colour printing is used for a wide range of work, including magazine and book printing, art reproduction, showcards, packaging, etc. In most cases line and half-tone blocks are used along with printers' type.

For various technical reasons colour line blocks are seldom made from coloured originals but rather from a line drawing, the colour plates being prepared by hand by the photoengraver with the aid of a colour sketch supplied by the artist. The line negatives are made on ordinary "blue sensitive" dry-plate or wet-collodion material.

The four-colour half-tone process is normally used for all coloured originals having gradation of tone, such as paintings, colour photographs on paper, or colour transparencies. Colour-separation negatives are made on panchromatic plates, using blue, green, and red light for the three records, while a fourth negative is required for the "black" printer. Normally the colour-separation negatives are made through a ruled screen positioned close to the sensitive plate so that the continuous-tones are translated into a dot structured image. The relevant optical and photographic considerations need not be detailed since they have little bearing on the question of illumination. The remaining steps of the process may be described briefly.

For line work it is usual to make an acid resist on zinc (or copper for fine work) by coating the sheet metal with a light-sensitive layer (dichromated albumen, glue, resin, etc.) and exposing behind the negative to suitable light. The coating is rendered insoluble in all places where the light is transmitted by the clear parts of the negative; the soluble parts are dissolved away. The resulting stencil-like image, which may be further hardened by heat treatment or other means, protects the lines of the image, while the spaces are etched to an appropriate depth in a suitable solution. Special techniques are used to protect the sides of the lines during etching. Essentially similar methods are used for half-tone, except that the metal is generally copper, and the sides of the dots are not normally protected.

The half-tone process does not give correct tone and colour reproduction automatically. If a plate is etched without the intervention of hand work, the lighter tones of the subject are flattened, and the middle and shadow tones are too light. In practice, gradation is modified by "fine-etching" in which advantage is taken of the lateral action of the etching solution to reduce the size of the dots locally. The fine-etcher protects the darkest tones with an acid-resisting paint, and the plate is etched until the dots representing the next few tones have been reduced to the required size. Further areas are then protected, and the plate is again etched, the staging being repeated until the high-light dots are etched to form small points.

This is normal practice in monochrome work; colour reproduction introduces additional and more difficult problems. The process is based on the idea that a wide range of colours can be matched by mixing or superimposing layers of pigments coloured yellow, magenta and cyan. Ideally each should absorb about one-third of the visible spectrum while reflecting the remainder. Available yellow inks approach the ideal, but the magenta and cyan inks have unwanted absorptions where they

* Formerly Head of the Department of Photographic Processes at the London School of Printing and Graphic Arts.

should reflect and incomplete absorptions in other regions. As a result of these and other factors changes in colour occur, the more obvious being that blues, greens and purples are darkened and degraded. Some colour correction can be effected by photographic masking, but final tone and colour corrections are made by fine-etching. The fine-etcher develops exceptional skill in evaluating colours and estimating dot sizes.

### Illuminants for Technical Operations

The essential requirements of an ideal illuminant for colour separation negative making are: (a) high intensity; (b) uniform distribution over a large area; (c) suitable spectral composition; (d) constant intensity.

It is not possible to completely satisfy all these conditions in practice.

For colour reproduction it is exceptional to illuminate the original with coloured light, although it is being done to a limited extent in the United States, filtered light from " white " or similar fluorescent tubes being used. The normal practice is to use more or less white light and to place colour filters in the optical path. The light source should have a continuous spectrum with no gaps in it, and sufficiently even distribution to permit reasonably uniform exposure times through each colour filter. Open arc lamps are preferred to enclosed arcs because the arc gap is smaller so that the contribution of visible light is greater in relation to the unwanted ultra-violet from the gas column. Generally lamps taking 30 amps or more are used. The nominal colour temperature is about 5,000 deg. K. Cored " white flame " carbons help to prevent the arc wandering and to raise the colour temperature. The illumination on the original is of the order of 500 lm./ft.$^2$. Intensity variations can be a source of trouble unless an integrating photo-electric exposure meter is used and the exposure is made in terms of light units rather than time.

There are not many alternative sources available. Relatively constant light output is given by tungsten gas-filled (half-watt) lamps of about 3,000 candle-power. Their colour temperature is only about 2,800 deg. K., necessitating a marked increase of exposure time through the blue filter. White fluorescent lamps have satisfactory spectral distribution for colour separation but their intensity is relatively low and they are seldom used. We have experimented with flash discharge lamps; the flash has very high intensity and short duration, so that the effective exposure is reduced owing to reciprocity failure. We found that about 10 successive discharges were required for monochrome line work with two lamps; many more would be needed for colour work.

For photographing colour transparencies by transmitted light the essential requirements are (a) high intensity, (b) fairly uniform spectral distribution, and (c) low temperature to avoid overheating the transparency. The following systems are used :—

(1) Compact high intensity source (gas-filled tungsten lamp) with condenser.

(2) Light from open arcs reflected from a white surface.

(3) Diffused light from a bank of white fluorescent lamps.

No system at present available is perfect. Very high intensity is required to keep the exposure time at a reasonable level, since the optical density of a colour transparency may be of the order of 3.0, so that only 0.001 of the incident light is transmitted; this requirement seems to be incompatible with a low temperature.

### Illuminants for Printing on Metal

The coatings of dichromated glue and albumen used in printing on metal, and the dichromated gelatine used in photogravure, are chiefly sensitive to ultra-violet and blue light. According to a recent determination([1]) dichromated albumen has maximum sensitivity at about 280 m$\mu$, with a secondary maximum between 360 and 400 m$\mu$, from which the curve drops to an insignificant value at about 550 m$\mu$ It is interesting to note that these data were obtained in research undertaken to provide a basis for the design of an efficient light source.

At present enclosed arc lamps are normally used at distances of 2-3 ft. with exposure times of the order of 10 minutes. In printing on metal a small light source is more likely to produce a sharp image than a large or diffused source. Compact, high-intensity metal arcs may ultimately provide the ideal illuminant. A diffused source is preferable for photogravure.

### Part 2.—Colour Control in Printing and Photoengraving

It is necessary to distinguish between different kinds of printing for which colour control requirements are not necessarily identical. Broadly, two distinct categories may be considered : (a) designs in which there are relatively large areas of more or less solid colour, such as in carton and label printing, and (b) reproductions of designs and pictures for advertising, book illustration, etc., for which the four-colour half-tone or similar process is generally used.

In carton printing and packaging, the work is produced in very large quantities and it must be uniform in quality. The public is quick to notice any variation in colour or other quality, especially when several packets are displayed together; lack of uniformity suggests variation in quality of the contents. Many people, often working independently, are concerned in the work. Principally they are the commercial artist, the photoengraver, the printer, and the purchaser, but there may also be advertising agents and other specialists whose opinions must be considered. The colour of the ink may be specified in a variety of ways, such as by reference to (a) the original art, (b) a colour sample, or (c) colour atlas notation. It is exceptional for trichromatic or spectrophotometric data to be supplied. The ink maker uses empirical methods in preparing a sample and arriving at a weight formula for bulk supply and repeat orders. In this work he may use daylight or an artificial illuminant for colour matching.

In printing on the machine, the original painting or colour samples must be matched and maintained within very close tolerances throughout the whole of the run. Here again an artificial illuminant may be used, but it may not be the same as that used by the ink maker. Differences about colour reproduction may arise between the different individuals concerned largely because there is no agreed standard of illumination. The difficulties are increased if the colour has to be altered to meet the wishes of the user, or because of variations in colour of different batches of paper, or to give better working properties on the machine.

Colour control depends largely on visual inspection. At some stages of the work the subjective impression of

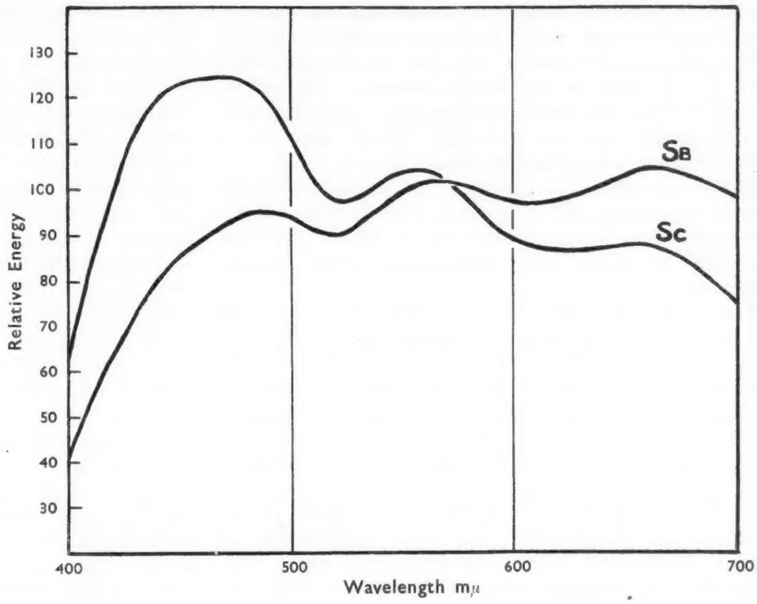



*Fig. 1. Relative spectral energy distribution of standard sources B and C.*

the design as a whole is important. In matching individual colours or in maintaining uniformity during the run, some form of instrumental control may be possible, but there are various reasons for regarding it only as an adjunct to visual judgment. There is the difficulty of designing a sufficiently accurate workshop instrument for use without time-consuming effort by personnel untrained in colour measurement. Further, the subjective appearance of ink printed on paper varies with the angles of illumination and viewing; variations can be judged best when the samples are held in the hand. Another reason, which applies in the case of visual colorimeters, is that colour estimation can be exercised better when the colour samples are large and can be viewed with both eyes rather than when seen as a small field through the eyepiece of an instrument.

In the reproduction of coloured originals by four-colour or similar methods, other considerations arise. The plate-making is often undertaken by a specialist photoengraving firm so that the difficulties of co-ordination are increased. Facsimile reproduction may involve the exact matching of local colour areas—this applies especially to botanical and medical work, and to advertising in which a realistic representation of commodities is required. In practice exact façsimile reproduction may be impossible, either because come of the colours of the original lie outside the range of the tricolour mixture or, for instance, because the art director or advertising agent may have in mind a colour scheme different from that of the original. In the reproduction of pictures it is often more important to interpret the original appropriately than to attempt to match each local colour area accurately.

The colour etcher is therefore concerned with both colour matching and colour interpretation, and ideally requires an illuminant of suitable and constant quality. This applies to most commercial work, but some oil paintings can only be viewed correctly under the same conditions of lighting as were used by the artist.

Suitable illuminants are also required for proofing, which, in the case of colour half-tone, is generally undertaken by specialists working in the photoengraving firm. In general the requirements for printing from the engraved plates are much the same as outlined for packaging and similar work, except that now the colour result is obtained by successive printings in four-colour inks in letterpress and photogravure, and often with five, six or more printings in lithography. Exact control of each printing within small tolerances is essential. The exact strength of the yellow and magenta printings cannot be fully appreciated until the cyan has been printed, so the printer endeavours to match the proof sheets, but (because printing conditions are different) he must also exercise judgment based on experience. The partial acceptance of standard inks for three- and four-colour work([2]) has helped to secure better co-operation between ink-maker, photoengraver and printer, but the need for control still remains.

## Characteristics of Pigments

The selective absorption characteristics of printing inks and artists' paints when illuminated by white light are of interest in relation to the choice of illuminants. In no case is there complete absorption anywhere throughout the visible spectrum, since some light which has not undergone selective absorption is always reflected at the surface. Yellow, orange and red pigments may reflect a high percentage (perhaps 90 per cent.) of the longer wavelengths and have fairly good absorption in other regions. The maximum reflection of greens and blues seldom exceeds 50 per cent., and the absorption regions are less clearly defined. The subjective brightness of greens is associated with the spectral sensitivity characteristics of the human eye.

A moderate change in the quality of the illuminant may produce only a small change in the subjective colour of pigments with broad reflection bands such as those we have considered. With a few dyes and pigments, however, the colour change under different illuminants is marked. They generally have high maxima in widely separated regions of the spectrum. It is also possible to find pigments

of different chemical composition and different spectral characteristics which have the same subjective colour under a particular illuminant, but which no longer match when viewed under a different illuminant. Metameric pairs of this kind are sometimes used for qualitative tests for illuminants, and an extension of the idea on a quantitative basis has been proposed.(3)

The characteristics of fluorescent inks are outside the scope of this paper, but it is worth while noting that we have sometimes found artists' paints which fluoresce sufficiently to affect their appearance under certain illuminants.

The visual appearance of ink printed on paper varies with the angles of viewing and illumination because the paper does not provide a perfectly diffusing surface, some of the light being scattered and some specularly reflected to a varying degree depending on the relative smoothness of the surface. This is especially noticeable with inks having marked "bronzing" characteristics. Thus a particular red printing ink may have a metallic yellow sheen if it is lighted and viewed so that much of the specular light reaches the eye. An explanation of bronzing phenomena and of the anomalous results produced when bronzing pigments are diluted with white has been given by W. D. Wright.(4)

### Illuminants for Colour Matching

The desirable qualities of an illuminant for matching and viewing colours will be considered with special reference to the requirements of colour reproduction and printing. In general it can be said that the illuminant should have a continuous spectrum with uniform distribution throughout the visible region, and sufficiently high intensity. This requires qualification because the spectra of some discharge sources in which the lines are very closely spaced may be suitable, and there is some latitude as regards uniform distribution. North-sky light has a fairly smooth distribution curve, but it rises in the blue region, and both colour quality and intensity vary considerably with time of day and time of year, and with atmospheric conditions. Nevertheless, North-sky daylight is still often preferred to any other illuminant for colour matching. Artists usually light their studios with North-sky daylight, but probably they, as well as colour matchers, would be equally well satisfied with sunlight or a mixture of sun and skylight if they were constant in quality and intensity.

A black body radiator with a colour temperature within the limits of average daylight may be regarded as an ideal standard of reference, and the C.I.E. sources B and C provide practical standards which approximate to full radiators. Source C (6,500 deg. K) was adopted as representative of daylight in the United States, while source B (4,800 deg. K) was accepted in this country. The choice of standard should be considered not only in relation to practical colour matching, but also to the conditions under which colours will be viewed by the general public. Printed work is normally seen by daylight and under various forms of fluorescent and incandescent lighting at various intensity levels. It seems reasonable to suppose that if colours "look right" by daylight they will at any rate be suitable for viewing under other illuminants. We deliberately ignore cases where printed work will be seen chiefly or only by artificial light (such as some Underground railway posters) or special requirements for fluorescent inks, etc., which must be considered on their merits.

In view of all the considerations we suggest that source C (6,500 deg. K.) should provide a satisfactory standard, being a compromise between average daylight and the artificial illuminants used now, which, on the whole, tend to have a higher colour temperature now than was usual a few years ago when incandescent lamps were chiefly used. Incidentally it is interesting to note that neither source B nor C has the smooth spectral distribution of a black body radiator. This is illustrated in Fig. 1, based on published data(5). Nevertheless the curves bear a marked resemblance to typical curves for a mixture of sunlight and skylight such as those published recently by J. N. Hull(6). The curves vary considerably with time of day, atmospheric pollution, and other conditions, but they all have a more or less pronounced maximum at about 460 to 490 m$\mu$ and a dip at about 520 m$\mu$ which are characteristics of the standard sources.

### Available Artificial Colour Matching Illuminants

Filtered tungsten gas-filled lamps can have satisfactory spectral distribution. The relative intensity at different wave-lengths for one such lamp is shown in Fig. 2, the standard of reference being source B. The measurements were made on a modified Hilger spectrophotometer. The initial photometric balance was made at about 460 m with a value of 50 on the relative intensity scale, so that a source which matched the standard lamp perfectly would be represented by a straight line at that level. It will be seen that the filtered tungsten lamp has a slightly higher colour temperature than the standard lamp. The most serious objection to this form of illuminant is its low efficiency (about 2 lumens per watt) and consequent low level of illumination; this means that the lamp can only

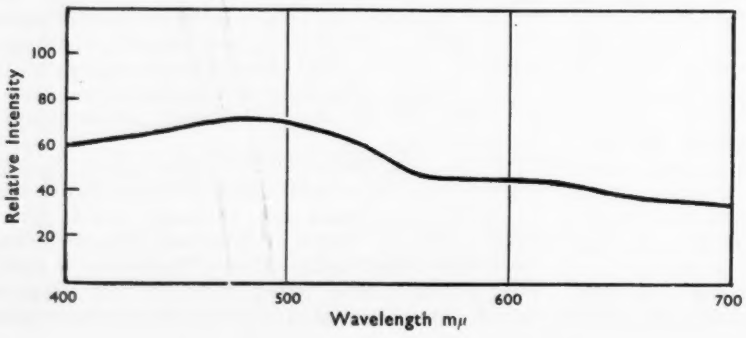



*Fig. 2. Spectral energy distribution of filtered tungsten lamp. The standard reference is source B.*

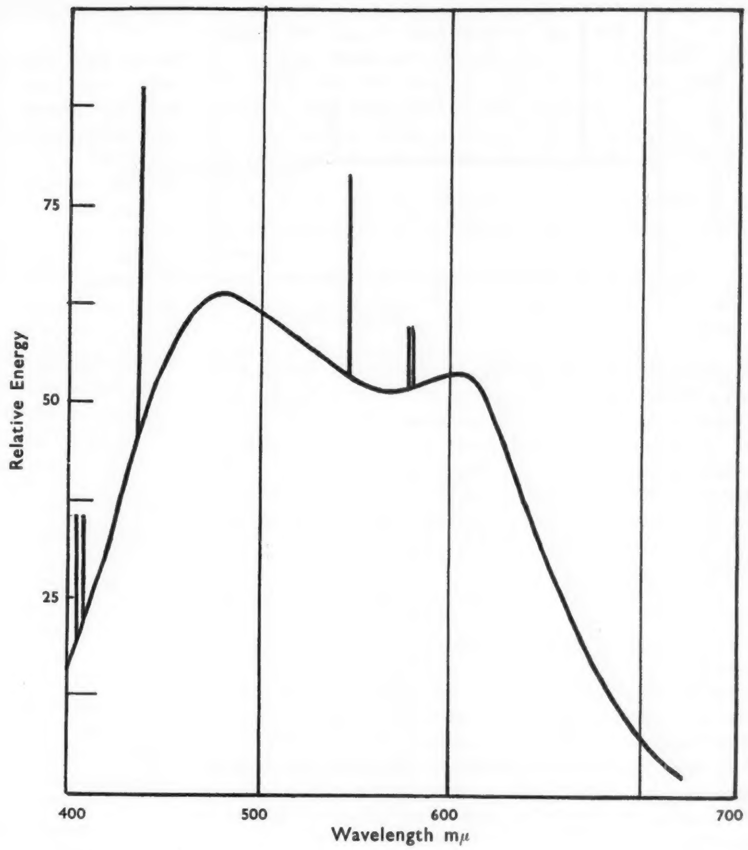



*Fig. 3. Spectral energy distribution of fluorescent lamp for colour matching.*

be used successfully for local lighting, for instance, over the colour etcher's bench, the proof press, or the delivery end of the printing machine, and it has to be placed inconveniently close to the work. Another objection is the lowering of colour temperature with the ageing of the tungsten lamp; a gradual change which is not usually detected until it has become very marked.

### Fluorescent Lamps

In general, hot cathode mains voltage fluorescent lamps are characterised by a continuous spectrum of somewhat uneven distribution with a marked drop at the red end, plus very prominent residual mercury lines. The lamps specially intended for colour work such as " Colour Matching White " and " Northlight " can be used with a fair measure of success. A typical spectral energy distribution curve (Fig. 3) shows that the residual mercury lines at 405 and 408 m$\mu$ are not very intense and they compensate to some extent for the drop in the continuous spectrum in that region. The yellow lines (577-580 m$\mu$) are fairly well suppressed, but the blue line at 435.8 m$\mu$ and the green line at 546 m$\mu$ are very intense.

It would appear at first sight that the presence of these lines would be a cause of serious colour changes, and the fact that they are not more marked (except in the case of metameric colours) is due largely to the broad banded character of the distribution curves of most of the pigments used in printing. The more obvious results are that yellow pigments tend to reflect slightly more green light than they do in daylight, and some observers consider that yellow-greens appear slightly more saturated. The lack of red in the fluorescent spectrum results in a lack of saturation of red and orange colours, and upsets the red-blue balance of purples. Despite these changes the lamps do, at any rate, provide a reasonably constant illuminant which is being widely used for colour matching.

### Blue Fluorescent with Tungsten Incandescent Illuminants

Another approach to the problem of providing a satisfactory illuminant for colour matching is to combine the light of blue fluorescent lamps with that of tungsten incandescent lamps. The fluorescent light supplements the short-wave radiations which are relatively deficient in the tungsten light, while the combination overcomes the difficulty of the red deficiency of the normal colour matching fluorescent lamps. Thanks to the co-operation of Dr. Strange and Dr. Henderson we were able to experiment with combinations of different fluorescent tubes and tungsten lamps, the colour temperature of which was controlled. To ensure a satisfactory mixture of light, the lamps were mounted in a large rectangular box painted white inside and provided with a suitably placed aperture through which the integrated light was received; this worked well in practice. The light was adjusted for overall colour and intensity to match the light of standard B lamp with the aid of a Lummer-Brodhun photometer.

Spectrophotometric measurements were made throughout the visible spectrum with reference to source B. As

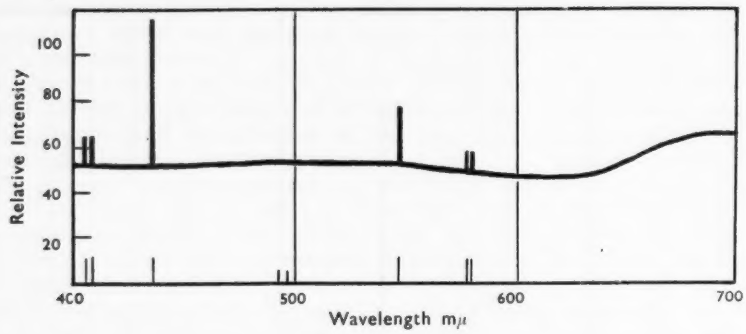



*Fig. 4. Spectral distribution of fluorescent plus tungsten illuminant. The standard of reference is source B.*

before a straight line parallel with the base would represent a perfect match. A typical curve (Fig. 4) shows the pronounced rise in the red necessary to compensate for the prominent blue and green lines. Incidentally the overall colour match was better than might have been expected when it is considered that the blue to green ratio is a fixed quantity for any particular fluorescent lamp and only the red content supplied by the tungsten lamps could be varied.

The relative intensity of the mercury lines (shown by vertical lines in the graph) is of the same order as with colour matching white illuminants, and their presence prevents completely satisfactory colour matching. Thus the same slight change in hue of yellows occurs, but the reds and purples are better rendered. Colour matching units based on this principle are now commercially available. The light is well mixed and diffused. The nominal colour temperature is said to be 6,500 deg K., and it can be modified by using incandescent lamps of higher or lower wattage(7).

## Evaluation of Colour Rendering Properties

The overall colour of an illuminant can be measured on a trichromatic basis and expressed in terms of C.I.E. chromoticity co-ordinates, but this gives no information regarding the spectral composition of the source on which its colour rendering properties depend. S.E.D. curves give complete information but take much time to make unless an automatic spectrophotometer is available, and the data cannot be expressed numerically in any simple way. The band system, in which S.E.D. measurements of the light flux in (say) eight bands of the visible spectrum are made, allows of the approximate spectral distribution being expressed by a series of numbers. The system, which has been criticised on theoretical ground(8), would appear to have useful practical applications.

The evaluation of colour rendering by means of coloured samples presents several difficulties and does not lend itself to numerical interpretation. Normally two identical sets of samples are used, one being illuminated by north-skylight or by an illuminant of known properties, the other by the illuminant under test. Even when care is taken in the choice of observers, and attention given to physiological conditions, such as adaptation, fatigue, etc., it is not easy to get clearly expressed opinions from observers, and still less to assess them on a quantitative basis. Nevertheless, skilled colour matchers use this method in deciding the respective merits of different illuminants. One critical test is the examination of near grey samples. Metameric pairs of colours are helpful, and an elaboration of the metameric test has been proposed recently(3). In any work of this kind it is important to first establish equality of illumination between the known source and the one under test.

As a refinement of ordinary visual matching technique we have adopted the principle of selecting samples of a particular colour of approximately equal luminance but having slight variations in hue or saturation or both. The certainty with which these variations can be detected gives a good indication of the colour rendering properties of the illuminant. Possibly the test could be systematised to give some form of quantitative evaluation.

## Intensity of Illumination

Experience has shown that the intensity of illumination given by artificial sources is almost as important as their colour rendering properties, which is, perhaps, surprising when we consider that colour work is often carried out in daylight with illumination constantly varying over a wide range. We have experimented with different levels of illumination from 30 to 100 lm./ft.$^2$. Colour etchers prefer an intensity of 50 lm./ft.$^2$ or more, and the optimum level appears to be between 70 and 80 lm./ft.$^2$, but an important factor is the placing of illuminants so as to avoid glare from the source itself, or by reflection from the work. A similar level of illumination appears to be satisfactory at proof presses, but illumination in the printing room presents special difficulties because good general lighting is required for machine operating in addition to that for colour matching. Sometimes one form of illuminant such as "white" fluorescent, giving general illumination at about 14 lm./ft.$^2$, is used, and special lamps or units are disposed locally for colour control. The mixture of illuminants of different colour quality is undesirable, and it would appear to be better to use the same type of colour matching illuminant throughout for general illumination, the lamps being disposed so as to give the higher illumination required for colour matching at strategic points, such as near to the delivery end of the machine.

## Practical Experience with Illuminants for Colour Matching

During last year we had practical experience in a building newly equipped with different forms of selected illuminants. In the colour etching section, "colour matching white" fluorescent lamps are used over the retouching benches. Colour etchers consider the lighting fairly satisfactory, though they are conscious of a slight lack of saturation of red colours. Critical observers note a tendency for the hue of some yellows to differ a little

from the daylight value, and the red-blue ratio of purples is slightly upset.

A section of the etching room is lighted with colour matching units (blue fluorescent plus tungsten). The colour rendering is better, especially as regards reds and purples, when the lamps are new. The change with age, in the direction of lower colour temperature, has been commented upon by experienced colour etchers. Similar units are used for proofing and the same remarks apply.

For photo-litho retouching we have used colour matching fluorescent lamps with variable intensity control for lighting the originals. The specially designed retouching desks are provided with similar lamps (also with intensity control). The illumination is regarded as fairly satisfactory, but the maximum available (50 lm./ft.$^2$) is nearly always used for lighting originals, and it is suggested that a still higher value would be welcome. In all these sections the opinion is freely expressed that daylight is always preferred when it is available.

We have made numerous inquiries of ink makers, colour etchers, retouchers, and printers regarding their experience with different illuminants for colour work. Some firms appear to have installed the wrong kind of lamp in the early days of fluorescent lighting, and have been prejudiced against any form of fluorescent lamp. In most cases, however, colour matching white fluorescent lamps or colour matching units have been installed, usually for local lighting. In one large firm all departments where colour work is carried out are lighted exclusively with colour matching lamps, night shifts are worked and it is considered that uniformity of lighting contributes materially to continuity of work and higher productivity.

In all cases the artificial illuminants are regarded as second best to daylight, which is used when possible. We understand that in at least one case, consideration is being given to the use of one form of artificial colour matching illuminant with the complete exclusion of daylight, on the ground that uniformity may be more important than extreme accuracy.

The comments of ink makers regarding the practical use of colour matching lamps are similar to those made by colour etchers and printers. They are, however, faced with the difficulty of matching samples with a mixture of inks which may then have more or less marked metameric properties. Similar difficulties arise in reformulating an ink for reasons relating to cost, light fastness, and other factors. They cannot then rely on fluorescent lamps, and may have to use filtered tungsten daylight lamps, followed by confirmation in daylight. This confirmation is generally necessary in the case of near greys, buffs, and other colours of low saturation.

The change in colour quality of fluorescent lamps with age has been commented upon, and it has been suggested that colour matching fluorescent lamps should be replaced after about 2,000 to 3,000 hours, the old lamps being used for general lighting in rooms where colour work is not carried out.

## Conclusions

1. The open arc lamps used for technical purposes in colour reproduction are satisfactory as regards colour quality and luminous intensity, but they are subject to serious intensity fluctuations.

2. Colour matching and control are required at many stages of colour printing and reproduction. It is desirable to provide an artificial illuminant of constant colour quality for use at all stages of the work.

3. The illuminant should have the essential quality of fairly uniform spectral distribution associated with daylight and especially North skylight.

4. A colour temperature of about 6,500 deg. K. and an illumination of 50-100 lm./ft.$^2$ would appear to be desirable.

5. Some existing filtered incandescent lamps have satisfactory spectral distribution but insufficient luminous intensity.

6. Special colour matching fluorescent lamps, much used in practice, have suitable intensity, but their spectral distribution is unbalanced by the presence of mercury lines and deficiency of red light. Colour matching units, combining the light of blue fluorescent and tungsten incandescent lamps, have better spectral characteristics except for the residual mercury lines which are still prominent.

7. Both these illuminants are used with some measure of success for colour correction in processes based essentially on the tri-colour principle, but they cannot be relied on for colour matching in ink making or for control in printing when inks or ink mixtures having metameric properties are used.


## Acknowledgments

The author gratefully acknowledges the co-operation of Dr. J. W. Strange and Dr. S. T. Henderson, who provided illuminants for experimental purposes, and is indebted to J. Rawlinson, chief engineer to the London County Council, for supplying technical information regarding the installation on which some of the practical experience mentioned in this paper was gained. Thanks are also due to numerous firms and individuals who have given information based on their experience with illuminants for colour work.


## References


(1) Koch, R. W., and Rossell, R. E., The Penrose Annual, **47,** 122 (1953).

(2) B.S., 1480 : 1949.

(3) Jerome, W., and Judd, D. B., Illuminating Engineering, **48,** 259-267 (1953).

(4) Wright, W. D., The Measurement of Colour, 176 (A. Hilger, 1944).

(5) Wright, W. D., The Measurement of Colour, 206 (A. Hilger, 1944).

(6) Hull, J. N., Trans. Illum. Eng. Soc. (London), **19,** 21 (1954).

(7) Harrison, W., The Penrose Annual, **47,** 137 (1953).

(8) Henderson, S. T., and Waigh, D. T., Trans. Illum. Eng. Soc. (London), **18,** 113 (1953).


---

The Practical Electrician's Pocket Book, which is published annually by Odhams Press, Ltd. (price 5s.), contains in a handy form quite an amount of useful information for the man on the job. The 1955 edition contains new chapters on illuminated signs and floodlighting.

The British Standards Yearbook, 1954, lists 2,500 British Standards current at March 31 this year. The Yearbook is a very useful source of reference for those who have to keep up to date in these matters.

The block on p.270 of the September issue was unfortunately printed upside down. Our apologies to readers and to Ekco-Ensign Electric, Ltd.

## Lighting Installation

# A Cafeteria

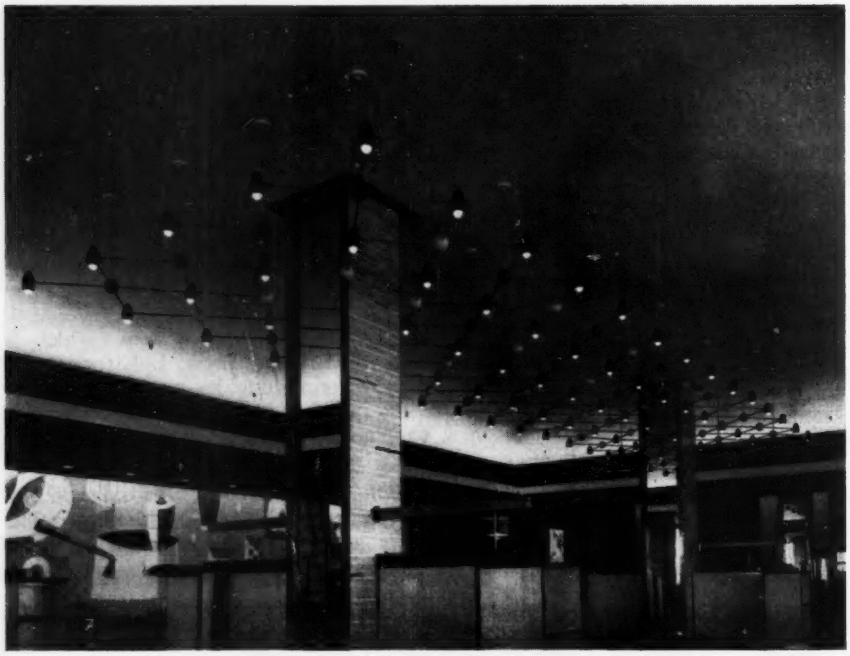
A successful solution to an unusual lighting problem has been achieved in the new Cafeteria of Lewis's, Liverpool.

The main architectural feature of the ceiling is a central recess 30 ft. by 60 ft. and approximately 3 ft. in height with a dark surround. This relatively small height in a recess of 30 ft. span makes even illumination of the ceiling difficult. The use of indirect lighting from fluorescent lamps within the surround of the recess would, in the normal course, produce areas of high brightness on the vertical walls adjacent to the lamps, contrasting badly with the lower brightness areas in the centre. Painting these vertical surfaces a matt dark green has lowered the reflectance, and this, in combination with specially designed fluorescent luminaires within the surrounds, has overcome the difficulty, a fairly even brightness over the whole area being attained.

A special George Forrest lighting feature, a number of 60-watt lamps in small metal spinnings on an open trellis frame, provides downward direct lighting where needed and, at the same time, serves to break up the large expanse of undecorated white ceiling. The combination of the dark surround, broken only by a single line of special 100-watt luminaires, and the matt white illuminated recess tends to increase the apparent height of the ceiling, which seems to "float" above its surroundings.

**Architect:** Bronek Katz.

**Lighting Consultants:** Thorn Electrical Industries, Ltd.



# A Comparison of Yellow and White Headlamp Beams

By V. J. JEHU,* M.Sc., A.Inst.P.

**A report on a recent investigation carried out at the Road Research Laboratory.**

After driving in France, many motorists return to this country with the opinion that driving at night is easier and safer in France because of the yellow headlight beams used there. A simple comparison of this sort, however, may be misleading, because there are other differences between headlight practice in France and in this country besides the colour of the light. The French regulations for meeting beams specify a maximum intensity near the horizontal plane, and a minimum intensity below the horizontal. The effect of this is to enforce the use of meeting beams which possess a more sharply defined upper limit and lower glare intensities above the horizontal than are usual in this country. Thus French meeting beams should appear less bright than their British counterparts, quite apart from the question of the colour of the light.

A great deal of laboratory work has been done on the influence of coloured light on seeing. The evidence which influenced the French to legislate in favour of yellow light was critically reviewed in this country in 1937([1]) and the evidence that less dazzle and greater facility of vision are associated with yellow headlight beams was found to be inconclusive. In this review no account was taken of personal preference, which was regarded as a disturbing factor impossible to calculate or to investigate experimentally.

So far as is known, previous comparisons between yellow and white light, except for vision in fog, have all consisted of laboratory measurements of factors such as minimum perceptible contrast, visual acuity, recovery time of the eye and the speed of reading. In many cases the test conditions bear little relation to those experienced by drivers at night. The tests to be described in this present article, however, were made under approximately natural conditions. They consisted of measurements of the distance at which a test object could be seen from a moving vehicle, and tests in which drivers were asked to express their preferences after experiencing actual meeting beams of both colours.

* The author is with the Road Research Laboratory, Department of Scientific and Industrial Research.

### Measurements of Seeing Distance

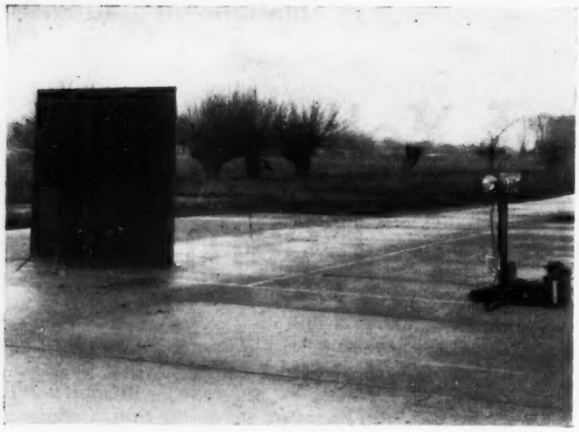
Observers in a car travelling at 30 m.p.h. on a straight test track measured the distance at which the orientation of a rectangular grey object, 21 in. by 12 in., could be distinguished, when seen against a dark background 8 ft. square, in the light of a lamp on the car (Fig. 1a). The luminance factors of the object and the background were about 7 per cent. and 2 per cent. respectively. The observer, who sat beside the driver, pressed a button which actuated distance-measuring apparatus when the object was distinguished, and released the button at the instant of passing the object.

Measurements were made with white and yellow light, both with and without the glare from stationary opposing lamps of the same colour, mounted 20 ft. to the right of the object and at the observer's eye level (Fig. 1a). The yellow light was that given by bulbs of cadmium sulphide glass as used in France. Widespread beams of uniform intensity were used so that the intensities directed at the object or at the observer's eyes would not vary during the runs. The yellow and white beams had substantially the same light distributions, the same spreader glass being used. In those runs in which glare was present the intensity of the glaring beam was one half that of the headlight on the vehicle.

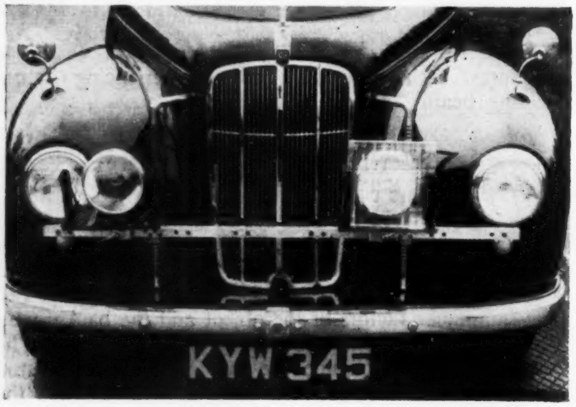
Each observer made 32 runs; 16 with white light and 16 with yellow light. Eight runs were first made with yellow light, taking the vehicle headlight intensities, 1,000, 2,000, 4,000 and 8,000 cd. in a random order, and making two runs with each, one with glare and one without. The procedure was then repeated with white light, and finally the set of 16 runs were repeated with another random order for the intensities.

Six observers were used in the tests, two women and two men in the 20-30 years age group, and two men aged about 40. All had normal colour vision as tested with the Ishihara charts.

The beam intensities were controlled by varying the applied voltage. Change of intensity was thus accompanied by some change of the colour temperature of the



(a) *The test object, background and glare lamps.*




(b) *Lamps on observer's car: note spreader glass giving uniform beam.*

*Fig. 1. Apparatus used in measurements of seeing distance with yellow and white light.*

filaments; even at the lowest intensities, however, light from the clear bulbs was unmistakably white compared with light from the yellow bulbs.

It was important that the measurements of the intensities of the white and yellow beams should not be invalidated by the colour difference. The voltage-intensity relationships for the lamps were determined in the laboratory using a photovoltaic cell fitted with a gelatine filter to correct its spectral response approximately to that of the average human eye. Any departure of the response of the cell from that of the average human eye would mean that intensities of the yellow and white beams, which were equal according to the cell, would not be so to the eye. As a check on the behaviour of this cell it was later compared with an emission cell fitted with a liquid Preston filter to accurately match its particular spectral response to that of the standard human eye.

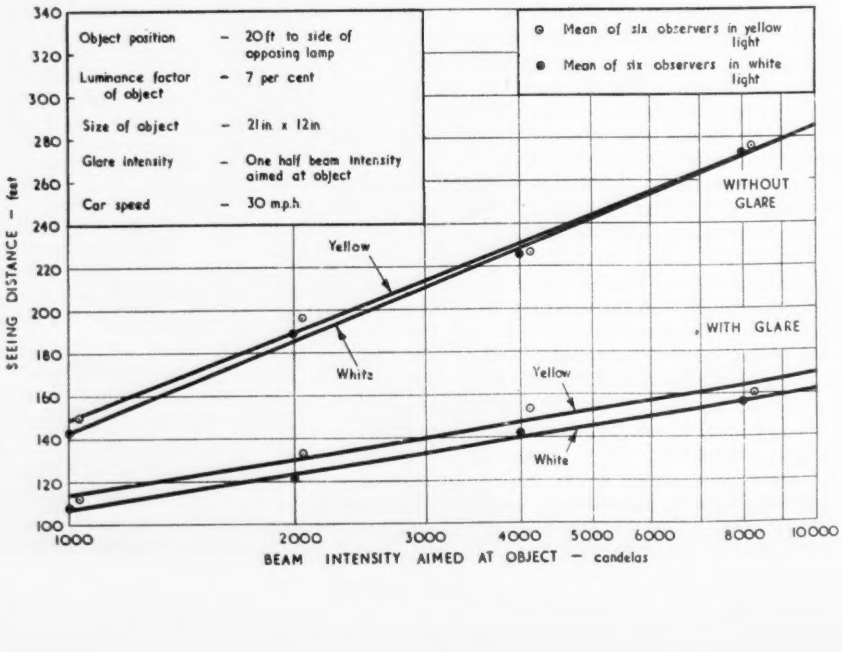
These check tests showed that the intensities of the yellow beams used in the measurements of seeing distance were 3 per cent. greater than those of the white beams. This difference in beam intensity has been taken into account in interpreting the results of seeing distance.

## Results

The seeing distances obtained are shown in Fig. 2, in which the plotted points are the means of the readings for the six observers at each specific intensity. The straight lines are those, found by calculation, which best fit the observations.

Fig. 2 shows that, with glare, there was a small difference in favour of yellow light. The mean values of the ratios of seeing distances in yellow light to those in white light obtained by the six observers were 1.15, 0.88, 1.03, 1.02, 1.23 and 1.09. These values are generally greater than unity, indicating that seeing distances were greater in yellow light: only one observer saw better, on the average, in white light when glare was present. The mean of the ratios is 1.07, but the individual values exhibit too large a variation among themselves to say

*Fig. 2. Seeing distances in yellow and white light.*



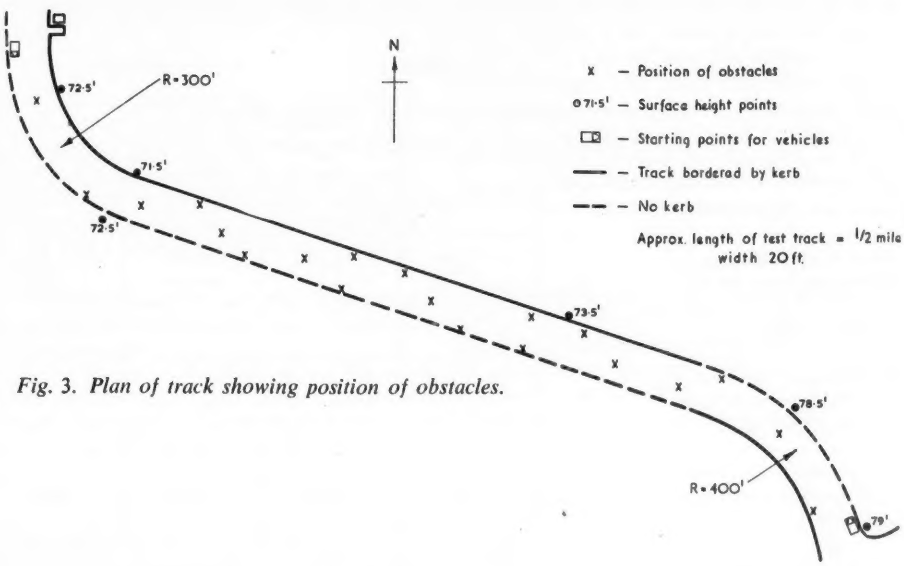



*Fig. 3. Plan of track showing position of obstacles.*

that the mean differs significantly from unity: the value of the mean may be expected to be between 0.97 and 1.17.

The above comparisons are made for beams of equal intensity irrespective of colour. In practice, however, if a filter is used on the lamp or if the clear glass bulbs are replaced by yellow bulbs of the same nominal wattage as the original clear bulbs, there is a loss of intensity, and the effect of this must also be taken into account. Measurements made in the laboratory showed that for the same wattage the light output of the particular yellow bulbs used was 18 per cent. less than that of the white bulbs. To compare the yellow and white systems in terms of equal wattage, seeing distances obtained from Fig 2 with an intensity $I$ in white light should be compared with those obtained with an intensity $0.82\ I$ in yellow light. It can be seen from the slope of the lines in Fig. 2 that if this is done the apparent difference between the seeing distances with glare would be very substantially reduced, whilst without glare the seeing distances in white light would become slightly greater than those in yellow light. The amount of light lost in transmission through yellow bulbs may vary between 5 per cent. and 20 per cent., so that it is not possible to make a general comparison between white and yellow bulbs in terms of equal wattage.

The measurements of seeing distance show that differences in seeing with yellow and white headlamp beams are small. It follows that the merits of the two colours can be judged solely by recording drivers' preferences under a variety of conditions likely to be encountered on the road at night. A strong preference for one colour or the other under most conditions would justify using headlamp beams of that colour.

## Driver-Opinion Tests

In these tests the observers drove vehicles equipped with yellow and white meeting beams of French design, so that the effect of colour could be assessed under realistic conditions. The assessment was made after the drivers had repeatedly negotiated a test course containing unlighted obstacles, meeting another vehicle using similar lamps on the straight part of the course(2).

The dimensions and layout of the test course are shown in Fig. 3. The course was chosen to provide a reasonable length of straight road with a curve at each end; one of these had a radius of curvature of 300 ft. and the other of 400 ft. Apart from minor fluctuations the track was level; there was a vertical concrete kerb on one side and no kerb on the other.

*Fig. 4. A view of the track showing some of the obstacles.*

Large obstacles consisting of rectangles of hessian on wooden frames were set up in two lanes, one at each side of the track; they had a luminance factor of about 6 per cent. Small cloth-covered obstacles were placed along the centre of the track; one side of these obstacles had a luminance factor of about 8 per cent., whilst the reverse side had a luminance factor of 2 per cent. A view of the track and some of the obstacles is shown in Fig. 4.

## Test Procedure

On any given night four observers took part in the tests, which included runs made first with the road dry and then with the road wetted by means of a water

### TABLE I

DRIVERS' OPINIONS OF SIMILAR MEETING BEAMS IN WHITE LIGHT (A) AND YELLOW LIGHT (B)

| Road surface | | High glare | | | | → | | | | | low glare |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Own lamp setting<br>Opposing lamp setting | — 1 deg.<br>+ 1 deg. | | — ½ deg.<br>+ ½ deg. | | correct<br>correct | | + ½ deg.<br>— ½ deg. | | + 1 deg.<br>— 1 deg. | |
| | Meeting beam | A | B | A | B | A | B | A | B | A | B |
| Dry | Preference: without glare | 18 | 2 | 16 | 4 | 18 | 2 | 18½ | 1½ | 18 | 2 |
| | Preference: with glare | 11 | 9 | 12½ | 7½ | 12½ | 7½ | 13 | 7 | 13½ | 6½ |
| | The less glaring system | 9 | 11 | 7½ | 12½ | 6½ | 13½ | 8 | 12 | 9½ | 10½ |
| | Proportion of observers judging difference in glare between A and B as small | 20/20 | | 20/20 | | 20/20 | | 20/20 | | 20/20 | |
| Wet | Preference: without glare | 19 | 1 | | | 17½ | 2½ | | | 19½ | ½ |
| | Preference: with glare | 10 | 10 | | | 12 | 8 | | | 9½ | 10½ |
| | The less glaring system | 7 | 13 | | | 8 | 12 | | | 9½ | 10½ |
| | Proportion of observers judging difference in glare between A and B as small | 20/20 | | | | 20/20 | | | | 20/20 | |

tanker. Runs were made first with lamps misaimed 1 deg., i.e., 1 deg. up on one vehicle and 1 deg. down on the other, then with ± ½ deg. misaim and finally with the correct setting. In this way the drivers experienced varying degrees of glare. After wetting the road runs were first made with correct aim and then with misaim of ± 1 deg. The vehicles always started at the same time from opposite ends of the track, so that they always met somewhere along the straight part, and so that the drivers always negotiated the curves at the ends of the track without experiencing glare from the opposing lamps. The drivers were not required to maintain any arbitrary speed, but to drive at the speeds they considered to be safe in the varying circumstances.

With a specific setting of the lamps each observer made four runs as driver and four runs as passenger, the lamps, designated by the letters A (white light) and B (yellow light), being switched in the order ABBAABBA, after which preferences and estimates of glare were recorded. When misaimed beams were compared the observers changed vehicles for another eight runs, to make their appraisals for misaim of the same amount but of reversed sign. No changing of vehicles was required with correctly aimed lamps. The complete programme on any given night usually occupied about two and a half to three hours of actual testing, half of which was spent by each observer as driver and half as passenger.

Twenty observers took part in the comparison, all of whom were accustomed to the use of white light. Seventeen of the observers had normal vision, and three subnormal colour vision, according to the Ishihara charts.

Each observer was provided with a questionnaire which was completed stage by stage as the tests proceeded. At the end of the eight runs with a specific setting of the lamps the observer recorded a preference for lamps A or B, both with and without glare, an opinion as to which system was the more glaring, and whether the difference in glare was large or small.

## The Lamps

Each vehicle was equipped with four lamps giving the characteristic sharp cut-off French meeting beam. Two alternate lamps on each vehicle were fitted with clear bulbs, and the others with yellow bulbs, in such a way that the sideways separation between the lamps on opposing vehicles was the same for the yellow and white systems.

The lamps were mounted on a bar which could be rotated about a horizontal axis so that the vertical aim of all the lamps on a vehicle could be varied together. Three preset positions of the bar provided a total movement of 1 deg. in ½ deg. steps. The lamps were aimed so that the alternative settings on one vehicle were ½ deg. and 1 deg. above the correct aim, whilst on the other vehicle they were ½ deg. and 1 deg. below the correct aim. In this way vertical misaim of ±½ deg. and ±1 deg. could be arranged quickly and accurately at the test site. When correctly set, the lamps were aimed with the cut-off of the meeting beam 0.6 deg. below the horizontal plane, and apart from minor differences between the bulbs selected, the beam distributions in the two colours were the same. Laboratory measurements showed that the mean light output of the yellow bulbs was 7 per cent. less than that of the clear bulbs at the same wattage. To compensate for this difference in intensity, the white bulbs used in the tests were run at a slightly reduced voltage

compared with the yellow bulbs (5.8 volts compared with 6.0 volts).

### Results

The preferences, and estimates of glare, are given in Table 1. The totals of the preferences expressed, both with and without glare, and the totals for the glare comparison of the two systems, all relate to 20 observers: half votes arise from observers having no preference. (In examining these totals it should be remembered that according to the $\chi^2$ test a vote of 15/5 is significant at the 5 per cent. level.)

Without glare the preference for the white beam was significant at all settings of the observers' lamps, both on a dry road and on a wet one.

With glare, opinions were more divided, and no significant results were obtained. Observers who considered the yellow beams less glaring than the white were always in the majority, a fact which shows that the observers' greater experience with white light did not prevent them favouring yellow light when they considered it to be superior. In spite of the glare estimates, however, the white beams were favoured in six out of the eight comparisons made, the voting being equal in one of the other two instances.

Coupled with the strong preference for white beams when there was no glare, this evidence can only mean that a driver's preference is not determined solely by the glare of the opposing beam; the characteristics of the driver's own beam may outweigh the glare consideration. This fact is of particular importance when it is remembered that much of the evidence in favour of yellow light comes from tests which, in a variety of ways, have compared only the glare effect of the two colours.

It is of interest to note that differences in glare between similar settings of the white and yellow beams were always considered to be small, i.e., if a lamp setting was such that the white beam produced a high level of glare, this was not much affected by changing to the yellow beam. This result discounts the view that dazzle can be avoided merely by substituting yellow bulbs for clear ones.

### Conclusion

The tests described show that a neutral-coloured object is seen almost equally well in yellow and in white light, and that glare estimates of similar meeting beams in the two colours are not very different. The one significant fact which emerges from a study of preferences is that most drivers prefer their own beam to be white.

### Acknowledgments

The work described in this article was carried out as part of the programme of the Road Research Board of the Department of Scientific and Industrial Research. The article is published by permission of the Director of Road Research.

### References

(1) Department of Scientific and Industrial Research. The use of coloured light for motor-car headlights. Illumination Research Technical Paper No. 20. London, 1937. (H.M. Stationery Office.)

(2) Grime, G. A substitute for road tests for automobile headlights. Proc. Highw. Res. Bd., Wash. (In the press.)

## Personal

Honorary Fellowship of the British Kinematograph Society has been awarded to PROF. W. D. WRIGHT in recognition of his work on colour vision and colour measurement and his current work on stereoscopy.

Those to whom Fellowship of the B.K.S. has recently been awarded include MR. G. E. FIELDING, chief engineer of the Associated British Picture Corporation, MR. R. L. HOULT of Pinewood Studios, MR. L. C. JESTY for his work on television, and MR. S. B. H. SWINGLER of the Circuit Managers Association Ltd.

Fellowship of the Illuminating Engineering Society has been awarded to MR. J. B. COLLINS of the Building Research Station and to MR. H. F. STEPHENSON of the Research Laboratories of the General Electric Co. Ltd.

The names of the following have been added to the Register of Lighting Engineers (I.E.S.):—

J. W. BESSANT, Thorn Electrical Industries Ltd., Leeds.
A. E. BIRD, British Thomson-Houston Co. Ltd., Leicester.
T. S. HARPER, British Thomson-Houston (S.A.) (Pty) Ltd., Johannesburg.
K. HAYWOOD, Smart and Brown (Eng.) Ltd., London.
M. G. A. JACKSON, Philips Electrical Ltd., London.
E. MILNER, Benjamin Electric Ltd., Skipton.
G. H. O'NEILL, Electricity Supply Board of Eire, Dublin.
C. STOCKTON, Edison Swan Electric Co. Ltd., London.

## Situations Vacant

Fully trained LIGHTING ENGINEER required for London office. Applicant must be well educated and conversant with modern lighting methods. Apply Senior Lighting Engineer, Ekco-Ensign Electric Ltd., 45, Essex-street, Strand, W.C.2.

A leading firm in the Lighting Industry requires two first-class DESIGNERS for design work in its Fittings Department. Work will be concerned with special designs and new developments, and offers very attractive prospects and salaries for men with real initiative and a sound experience in this field. Applications should be addressed to the Staff Manager, Box No. 863, giving full details of training, experience and qualifications.

JUNIOR LIGHTING ENGINEER required to assist in the preparation of lighting layouts and estimates. Previous experience in similar position desirable. Reply stating age and experience to the Manager, Troughton & Young (Lighting) Ltd., 143, Knightsbridge, S.W.1.

REPRESENTATIVE. The Merchant Adventurers Ltd., manufacturers of lighting fittings, have a vacancy on their technical sales staff, handling quality products on a salary basis, in London. Applicants should be capable of negotiating at high level, contacting architects, consulting engineers, Ministries, contractors and wholesalers. Write giving details of posts held and salaries earned. MA Ltd., 43, Portland Road, W.11.

CHARTERED ELECTRICAL ENGINEER required by a large retail organisation of national repute, to advise the Chief Architect to whom he will be directly responsible, on the design, installation and general work concerning the lighting of shops. Previous experience of modern lighting design is essential and a knowledge of heating and ventilation would be an advantage. Age not over 40. Salary £1,500, or higher, will be offered according to experience. The post is pensionable. Applications, by letter only, giving full details of experience, should be addressed to: The Secretary, The Professional Engineers Appointments Bureau, 9, Victoria Street, Westminster, London, S.W.1.

# Railway Station Lighting


*Fig. 1. Night-time appearance of the roofed section of the new Twickenham Station.*

One of the problems which confront the railway lighting engineer is ensuring that the name of a station can be readily seen by passengers travelling after dark. The Southern Region of British Railways has tackled this problem at the new Twickenham Station by installing luminaires for platform lighting which also display the name of the station in 3½ in. letters.

The luminaires and the pre-stressed concrete poles supporting the luminaires on the uncovered parts of the platforms were designed by the Civil Engineer's Department of Southern Region in conjunction with the Architect of the British Transport Commission to suit the amenities of the new station; both luminaires and columns conform with the recommendations of the Civil and Electrical Engineers' Joint Policy Lighting Sub-Committee of British Railways. The luminaires are erected at right angles to the track so that the name can be seen easily from the carriages.

The luminaires used to light the covered parts of the platforms were manufactured by Metropolitan Vickers Electrical Co., Ltd., and are fitted with single 5-ft. 80-watt or 4-ft. 40-watt new warm white fluorescent lamps. The units are fixed to the underside of the canopy with a mounting height of 9 ft. from platform to light source; they are spaced at 16 ft. centres, the smaller units being used adjacent to platform buildings. The luminaire consists of a ⅛ in. thick 040 opal "Perspex" trough with the station name engraved on both sides by the Compra Plastics Ltd. process. This trough is carried in a metal frame which is hinged from a back plate which fits flush to the ceiling. Centrally mounted on the back plate is a metal box containing the control gear; integral brackets each end of box form the means of suspension through special bolts to similar brackets fixed to the purlins. This box and fixing bolts are above ceiling level and access

*Fig. 2. Showing day-time appearance of the fluorescent luminaires.*

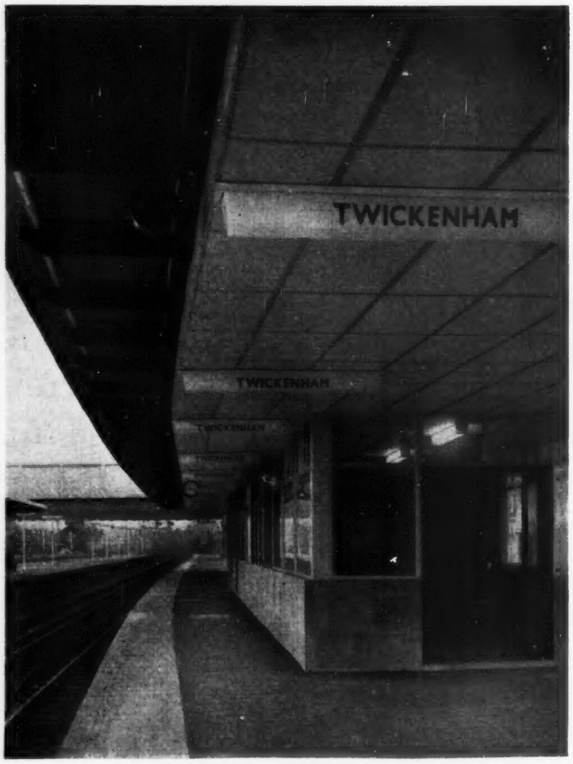



*Fig. 3. 5-ft. fluorescent luminaire used in roofed part of the station.*

for fixing and inspection is achieved by a panel adjacent to each luminaire. The minimum illumination on the covered parts of the platform is 1 lm./ft.$^2$ with a diversity over the whole platform not exceeding 3:1.

The uncovered parts of the platforms are lighted by specially designed luminaires manufactured by the General Electric Co., Ltd., each containing three 5-ft. 80-watt new warm white fluorescent lamps. They are arranged for easy conversion during manufacture for either post-top mounting or for suspension; both types are in use on the new station. Mounting height of the units is 12 ft. 6 in. from platform to the centre of the luminaire; spacing is 40 ft. along the centre of the platform. The luminaire consists of an extruded metal U section beam to which castings are attached at each end, and, when required for post mounting, a centrally placed spigot cap. Within the U section is housed all the control gear. The top of the unit is curved sheet-metal attached to the end castings and connecting frame; hinged from the frame on each side are "Perspex" doors on which the station name is engraved by the same process as used for the undercover luminaires. Conversion from post-top mounting to suspension type can readily be achieved by the addition of two simple castings and nuts with gaskets. The luminaires are designed for ease of maintenance; the "Perspex" doors of the lantern hinge upwards for access to the lamps and are supported automatically in the open position by struts. When the lantern is opened in this way the three sets of instant start gear housed in the bottom channel are also accessible.

The columns on which the post-top luminaires are mounted were manufactured by Anglian Products Ltd., to British Railways' design. The aluminium bronze alloy neck of the lantern fits over a steel tube which runs up the column; the lantern is secured by a single nut supplemented by dowels to prevent twisting. A feature of the design is the small cross-section of the columns (only 3½ in. square at the top) and the slender aluminium neck of the lantern which has a 3 in. cross-sectional area.

Switching of all units is arranged to effect the maximum economy in current consumption. The luminaires fitted to the canopy roof on each platform are switched alternately and the luminaires on the uncovered parts of the platforms are arranged so that one, two or three lamps can be used according to the requirements of passenger traffic.

It is understood that consideration is now being given by the Southern Region of British Railways to the design of other internally illuminated signs in place of the enamelled iron signs at present used on stations for a variety of purposes.

*Fig. 4. Night-time view of the uncovered part of Twickenham Station.*

# The S.B.A.C. Display

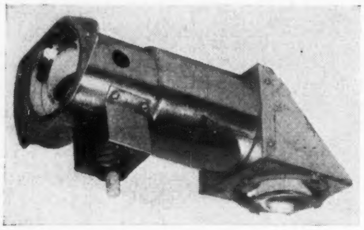
A number of firms in the lighting industry showed items in the annual display of the Society of British Aircraft Constructors, held at Farnborough from September 7 to 12.

The General Electric Co., Ltd., showed a new spotlight fitting designed for the Britannia aircraft in conjunction with the Bristol Aeroplane Co., Ltd. Its purpose is to provide light for reading at individual passenger seats, the optical system being designed to give a 17-in. diameter circle of light at 3 ft. with an intensity of 6 lm./ft.$^2$. A push-button switch is incorporated. The lens head can be rotated slightly on installation in order to ensure that the light is accurately directed on to each seat.

Another new development in equipment for localised lighting was the G.E.C. breast battery lighting set, consisting of an adjustable webbing harness carrying a miner's-type lamp and battery so that the wearer has his hands free for work, while the light is automatically directed where required by the attitude of his body. If desired the lamp can be carried instead on an adjustable head harness. The equipment is specially suitable for the night fuelling of aircraft, and is certified by the Ministry of Fuel and Power as intrinsically safe in pentane, butane, hexane, heptane, acetone, carbon monoxide, cyclohexane, and benzene atrospheres. An Osram 3.5-volt, 0.3-amp. M.E.S. bulb is fitted in the lamp, and takes its supply from three standard G.E.C. unit cells encased in a sealed moulded container attached to the waist belt at the back. The flexible connecting cable passes through a webbing tunnel sewn to one of the shoulder straps and is therefore secured close to the body. Switching is effected by rotation of the moulded front ring of the lamp. This equipment was developed by the G.E.C. in conjunction with Shell Mex and B.P., Limited.

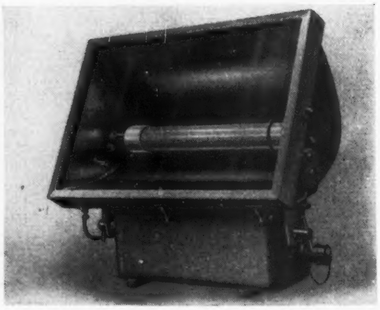
A new item of airfield lighting equipment was a flush-mounting runway light designed to meet the increasingly rigorous conditions imposed when lights of this type are run over by modern high-speed aircraft with tyres inflated to high pressures. Shock and stresses to aircraft are minimised by the projection above ground being less than 1½ in. The body of the fitting below ground level is very strongly constructed. The light takes a 12-volt, 100-watt lamp.

Philips Electrical, Limited, showed as their principal exhibit a new light-weight fluorescent lighting system for aircraft. One of the features of the system is that it can be operated on DC supplies. The need to reverse polarity to prevent " black ending " due to migration of mercury particles to the cathode at normal temperatures is avoided. Because it can be connected directly to batteries or DC supply the system does not require converting and regulating gear. Stabiliser control ensures that variations of supply voltage cause only very slight changes in light output, and a semi-conducting strip facilitates instant starting over a wide range of battery or supply voltages, without blinking. The lamp filaments are extremely robust and have great resistance to the effects of vibration. The very simple circuit reduces the problem of radio interference, and it is claimed that the lamps combine long life with twice the circuit efficiency of filament lamps usually employed. The system has already been adopted for use in the Bristol Britannia aircraft, shortly going into service with B.O.A.C.



*Spotlight fitting for " Britannia " aircraft.*

*Breast battery lighting set.*



*Revo 140-watt sodium flare mounted on gear box.*

Revo Electric Co., Ltd., showed a range of their airfield lighting fittings, including various types of obstruction lights, floodlights, uni-directional and omni-directional approach lights for pole and ground mounting, elevated and sunken taxi-way lights, sodium flares, control gear, etc.

The Aircraft Components Division of Thorn Electrical Industries showed a range of their aircraft lighting equipment and panel and indicator lamps. A fluorescent luminaire for the lighting of control rooms and portable fluorescent lighting equipment which can be used in confined spaces within an aircraft structure were also displayed.

# Lighting Abstracts

## OPTICS AND PHOTOMETRY

535,2 : 628.92

**82. Measurements of sky luminance in Stockholm.**
R. G. HOPKINSON. *Ljuskultur,* **26,** 48-50 (*No.* 2, 1954) *In Swedish.*

A summary of sky luminance measurements undertaken for the Swedish National Illumination Committee. Overcast skies were found to follow the Moon and Spencer formula, originally derived for latitude 40 deg. N. approx., confirmed for 52 deg. N. (Garston, Watford, England), and now for Stockholm (latitude 60 deg. N.). R. G. H.

535.2

**83. Some data and constants of materials in connection with ultra-violet radiation.**
G. SILJEHOLM AND G. GUNTHER. *Ljuskultur,* **26,** 35-44 (*No.* 2, 1954). *In Swedish.*

A general review of the ultra-violet region of the spectrum is given. Units in current use are defined, and tables given of the erythemal and bactericidal effects of radiation of different wavelengths. The transmissions to U.V. of different standard and special glasses and plastic materials are tabulated, and the spectral transmission is given of a liquid filter devised by Bäckström for selective transmission in the 2,200-3,400Å region. The absorption coefficients of various liquids to U.V. (2,537Å and 3,025Å) are also tabulated. Tables of reflection factors of 16 metallic surfaces to U.V. of 800, 2,000, 3,000 and 4,000Å are given, of which aluminium, with a high reflection to all wavelengths beyond 2,000Å, is outstanding; and the reflection factors of various white materials are listed. Various chemical reactions under U.V. irradiation are described. The problems associated with the detection and measurement of U.V. radiation are discussed. R. G. H.

621.326

## LAMP AND FITTINGS

**84. The beginnings of the electric filament lamp.**
W. KÖHLER. *Lichttechnik,* **6,** 211-213 (*June,* 1954). *In German.*

An historical account of the invention of the filament lamp, mainly concerned with the work of Heinrich Goebel, J. W. Swan and T. A. Edison. The author summarises the respective contributions of these workers as follows: Goebel was the first to make practical filament lamps (in 1854) and to use them for ordinary lighting purposes; Swan was the first to demonstrate filament lamps at such a stage of development that their manufacture on a factory scale could be undertaken shortly afterwards; Edison, working independently, produced lamps of practical design and, applying them for general lighting purposes, initiated the technology of lighting. J. W. T. W.

621.327.43

**85. Supposed visual disabilities under fluorescent lighting.**
H. SCHOBER. *Lichttechnik,* **6,** 215-218 (*June,* 1954). *In German.*

This paper was read before the German Illuminating Engineering Society at its recent annual conference. The author divides the complaints of ills due to fluorescent lighting into two classes, those which are made while the installation is still novel and which soon cease and those which persist and which may not be made until some time after the lighting has been installed. He examines the differences between fluorescent lighting and lighting from other sources, especially daylight and filament lamps, and attempts to trace possible causes for the persistent troubles. Among the relevant differences he notes the light distribution, differences in shadow formation, colour distortion and periodicity. He rules out any possible effects of U.V. radiation. There may be causes of trouble not directly due to the lighting, such as night work or lack of ventilation in windowless rooms. J. W. T. W.

621.327.43

**86. I.E.S. Guide for the electrical measurements of fluorescent lamps.**
*Illum. Engng.,* **49,** 267-270 (*May,* 1954).

This guide, which replaces one issued in 1948, specifies the conditions under which electrical measurements on fluorescent lamps should be made. For example, to compensate for the presence of a voltmeter, ammeter and wattmeter in the circuit, the lamp luminance should be monitored by a photocell and restored to its original value by an adjustment of the supply voltage after insertion of the instruments. P. P.

## LIGHTING

628.92

**87. Daylight survey methods.**
E. E. VEZEY, B. H. REED AND B. H. EVANS, *Illum. Engng.,* **49,** 245-250 (*May,* 1954).

The effect which changing sky conditions have on measurements of daylight factor has been studied by continuously recording the indoor and outdoor illuminations. The degree of variability of the measured daylight factor is discussed. In another similar study the indoor illumination was related to the illumination received on the window from the sky (the Sky Daylight Factor) and from the ground (the Ground Daylight Factor). P. P.

628.971.6

**88. New lighting installation in the tunnel under the Elbe at Hamburg.**
W. A. KRAUSE, *Lichttechnik,* **6,** 213-215 (*June,* 1954). *In German.*

Before the war this tunnel was lighted solely by filament lamps, and immediately after the war a number of special fittings, designed to withstand the special conditions of moisture and corrosion, were installed, but the sources were still filament lamps. In 1951 a complete relighting was carried out with bare fluorescent lamps mounted across the tunnel axis at 9-metre spacing. Glare is not objectionable because of the white tile inner surface of the tunnel. The average illumination initially was 2 lm./ft.$^2$, but after two years' operation this fell to 1.25 lm./ft.$^2$. Of the 98 lamps in service, none failed before completing 3,000 hours burning, five failed between 3,000 and 15,000 hours, and 24 at periods greater than 15,000 hours. The supply is three-phase and successive lamps are on different phases. J. W. T. W.

**89. Schools, a symposium.** 628.972
B. THORNBERG, E. BORG, O. WAHLSTROM, T. AXEN, P. HEDQVIST, E. RAGNDAL, S. E. RASMUSSEN, H. ZIMDAHL, G. ABERGH. *Byggmästaren* **33,** 77-112 (A4, 1954). *In Swedish.*

A symposium on school building in Sweden. Comparisons are made with recent English practice. Axén (p. 88) considers that fluorescent lighting is a suitable light source for supplementing twilight, but feels that fluorescent light fittings make a " melancholy chapter "—diffusing glass makes " warm white " light " cold " again, plastic materials absorb too much light and attract the dust. He has designed a simple fitting with a glare shield fixed to the lamp, which has cut fittings costs by half. R. G. H.

# Lighting Glass

Fig. 1. *Committee Room.*

The Glass Manufacturers' Federation recently moved into new premises at 19, Portland Place, London, W.1. The building was completely redecorated and refurnished to a scheme undertaken by Lady Casson on behalf of the Royal College of Art. The house is of the Adams period and the scheme of furnishing and decoration combines contemporary design with the period setting. Special luminaires—naturally of glass—were designed for the various rooms.

Fig. 1 shows the main committee room, which is lit by a luminaire designed by Lady Casson and Michael Goulding, of the Royal College of Art. The frame and

Fig. 2. *Notice board in entrance hall.*

Fig. 3. *Corridor.*

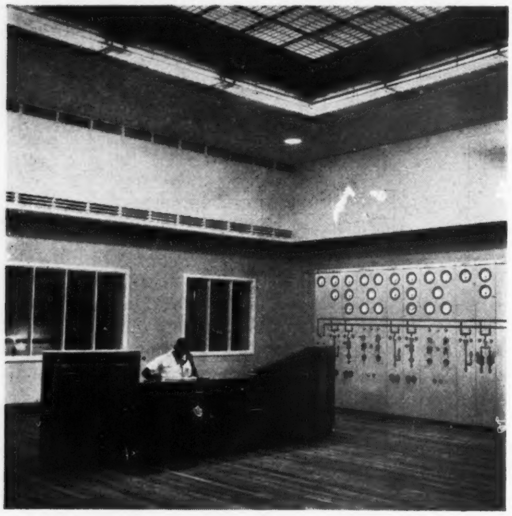
the opal top shades of the individual lights were made by Hailwood and Ackroyd; the lower shades were made by Bowman's from Chance Bros. flashed blue glass and carry a design obtained by cutting through the blue flashing to the clear glass beneath. The interiors of these lower shades are sandblasted to diffuse the light from the two 75-watt lamps carried in each unit. Above each of the opal shades is a 25-watt lamp to light up the Adam ceiling.

Fig. 2 shows the lighting arrangements for the notice board in the entrance hall. The luminaires were designed by L. S. Rider and made by Hailwood and Ackroyd; they are made of tri-ply ruby glass with a cut decoration. Each luminaire carries two 75-watt lamps.

Fig. 3 shows the lighting of a corridor. The ceiling is panelled with Pilkington " pin-stripe " sheet glass concealing fluorescent lamps above. The panel nearest the door is of ply-glass. The window wall on the right is fitted with Chance " spotlyte " glass.

## Lighting Installation

# Owen Falls Hydro-Electric Station



*Control room.*

An interesting installation is that for the control room, entrance hall and conference room at the new Owen Falls hydro-electric station of the Uganda Electricity Board.

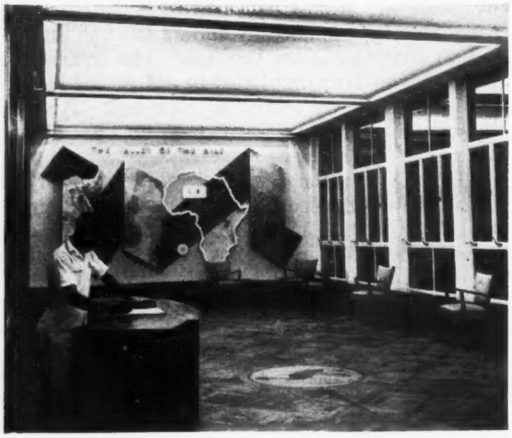
A continuous rectangular luminaire supporting a metal louvre and with reeded glass sides is partly recessed into the control room ceiling. The twenty-four 5 ft. 80-watt "warm white" hot cathode lamps in this luminaire provide an average service illumination of 15 lm./ft.$^2$. To light the walkway behind the control boards four 100-watt recessed tungsten units are mounted one in each corner of the room; and to provide additional lighting for the vertical surfaces of the panels two 150-watt spotlight reflector lamps with internally silvered bulbs in spun aluminium housings are situated above the controller's desk. To avoid brightness contrast between the lower ceiling level with the semi-recessed fitting, and the higher central well, four 5-ft. 80-watt batten type luminaires are mounted at the top of the well.

*Conference room.*

In the entrance hall four cornice features in white stove-enamelled sheet steel contain a single line of "warm white" cold cathode tubing. The base of the luminaires is formed of a grille of longitudinal fins to provide direct downward illumination and also to avoid accumulation of insects in the cornice. The tubes are operated from transformers mounted remotely. This part of the installation was designed for an average illumination of 10 lm./ft.$^2$.

In the conference room a specially designed suspended cold cathode luminaire accommodates 68 ft. of "warm white" cold cathode tubing operated at 120 ma. to provide the main illumination. The body of this luminaire is a sheet steel framework supporting a polystyrene louvre. Four 100-watt louvred tungsten luminaires recessed in the false ceiling provide additional illumination, the planned average intensity being 15 lm./ft.$^2$.

*Entrance hall.*



**Designed by:** G.E.C., Ltd., and Sir Alexander Gibbs and Partners.

**Installed by:** Electrical Installations, Ltd.

# I.E.S. Activities

## Regional Chairmen—Session 1954-55

**Bath and Bristol**

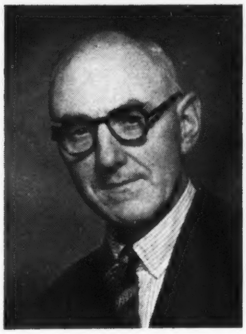
Mr. D. E. Beard joined Philips Electrical, Ltd., in London in 1936. After service with the Royal Signals during the war he returned to the company and was appointed lighting engineer in the West Country. He was appointed branch manager at Bristol in 1949. He is a Registered Lighting Engineer.

**Gloucester and Cheltenham**

Mr. F. W. Ricketts was educated at Cheltenham Grammar School, after which he served an apprenticeship in electrical contracting. He was a founder partner of the firm of W. T. Turner and Co., electrical heating and ventilating engineers and contractors, Gloucester.

**Birmingham**

Mr. F. W. Haynes served with the King's African Rifles during the 1914-18 war after which he joined the firm of Docker Bros. as Works Electrical Engineer, an appointment which he still holds. He was awarded the British Empire Medal for civil services in 1950.



**Leeds**

Mr. J. R. Bardsley has been with Cryselco, Ltd., for a number of years. After service with the Royal Signals during the war he returned to the Manchester branch. He was later transferred to Sheffield, and is now manager of the Leeds branch of Cryselco, Ltd.

**Edinburgh**

Mr. T. M. Christie joined the G.E.C., Ltd., in 1936. He studied at the Royal Technical College and Stow College, Glasgow, and spent some time at the G.E.C. Research Laboratories. He passed the City and Guilds final examination in 1948, and was appointed manager of the Lighting Department, G.E.C., Edinburgh, in 1949. He is a Registered Lighting Engineer.

**Liverpool**

Mr. G. W. A. Illingworth was educated at Southport University School and Southport Technical College. He joined the Southport Corporation Gas Department in 1922, and in 1944 became District Superintendent. On nationalisation of the gas industry he was appointed Borough Lighting Engineer of Southport. He served on the 1954 Summer Meeting Committee.

**Glasgow**

Mr. A. S. Bonn joined the Caledonian Railway Company in 1915 as an apprentice. He subsequently served in various departments, and later was on the outdoor machinery and electrical engineering staff of Scottish Region, B.R. He took up his present appointment as lighting assistant with Scottish Region, B.R., in 1948.

**Manchester**

Mr. W. C. G. Bailey spent his early years in the industry with the Metropolitan Vickers Electrical Co., Ltd. In 1924 he joined Falk, Stadelmann and Co., Ltd., and after the last war was appointed chief lighting engineer of their Manchester branch. He has been a member of the I.E.S. since 1931. He is a Registered Lighting Engineer.

**Nottingham**

Dr. A. Roberts is lecturer in mining at the University of Nottingham, having previously worked in the coal-mining industry in Lancashire and in the goldfields of West Africa. He is an Associate Member of the Institution of Civil Engineers, the Institution of Mining Engineers and the Institution of Mining and Metallurgy. He is a member of the Mine Lighting sub-committee of the N.I.C.

**Stoke-on-Trent**

Mr. R. J. Jones, A.M.I.E.E., was educated at Hanley High School and the North Staffs Technical College. He has been with the firm of Tomlins, Ltd., electrical contractors of Tunstall, for 28 years, and is now a director of the company. He is hon. secretary of the Potteries branch of the E.C.A.

**Sheffield**

Mr. C. J. Chisholm received his early training in public lighting with the Glasgow Corporation Lighting Department. He was appointed Lighting Engineer to the County Borough of Stockport in 1934, and in 1946 took up a similar post with the Burgh of Greenock. Since 1950 he has been Lighting Engineer to the City of Sheffield.

**Transvaal**

Mr. F. L. Cator, B.Sc., A.M.I.E.E., F.I.E.S., was born in Bulawayo. Educated at Malvern College, he joined the B.T.H. Co., Ltd., in 1926. In 1946 he joined E. K. Cole, Ltd., and in 1948 he returned to South Africa to start the Lighting and Merchandising Department of the newly formed B.T.H. (S.A.) (Pty.), Ltd. In 1953 he joined the staff of Hubert Davies and Co., Ltd.

**North Lancashire**

Mr. H. Carpenter, M.I.E.E., was, before the war, with the Thornton - Cleveleys Electricity Undertaking; he was appointed Chief Electrical Engineer on his return after war service with the technical and scientific staff of the Admiralty. In 1950 he took up his present position as Illuminations and Street Lighting Officer to the Blackpool Corporation.

The chairmen of the other Centres and Groups are :—

**Cardiff Centre.**—Mr. W. A. Cooper.

**Leicester Centre.**—Mr. B. V. Rowe.

**Newcastle Centre.**—Mr. T. E. Dellow.

**Swansea Group.**—Mr. A. V. Sinclair.

**Tees-side Group.**—Mr. K. Graham.

# I.E.S. Forthcoming Meetings

## LONDON

**October 8th**

Sessional Meeting. Presidential Address, by E. C. Lennox. (At the Royal Institution, Albemarle Street, W.1.) 6 p.m.

## CENTRES AND GROUPS

**October 4th**

LEEDS.—"Modelling with Light and Colour," by J. W. Howell. (At the Lecture Theatre of the Yorkshire Electricity Board, Ferensway, Hull.) 7.30 p.m.

**October 6th**

EDINBURGH.—"Home Lighting," by A. H. Young and C. J. Misselbrook. (At the Manor Club, 12, Rothesay Place, Edinburgh, 3.) 7 p.m.

NEWCASTLE.—Chairman's Address, by T. E. Dellow. (At the Liberal Club, Pilgrim Street.) 6.15 p.m.

SWANSEA.—Chairman's Address, by A. V. Sinclair. (At the South Wales Electricity Board's Demonstration Theatre, The Kingsway, Swansea.) 6.30 p.m.

**October 7th**

CARDIFF.—Film Evening. (At the South Wales Electricity Board's Demonstration Theatre. The Hayes, Cardiff.) 5.45 p.m.

GLASGOW.—"Home Lighting," by A. H. Young and C. J. Misselbrook. (At the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, C.2.) 7.30 p.m.

LEEDS.—Supper Dance. (At the Astoria Ballroom, Leeds.)

NOTTINGHAM.—Chairman's Address, "The Lighting Engineer Gets Down to Earth," by A. Roberts. (At the Nottingham and District Technical College.) 6 p.m.

**October 11th**

SHEFFIELD.—Chairman's Address, by C. J. Chisholm. (Venue to be announced.) 6.30 p.m.

**October 12th**

STOKE-ON-TRENT.—"Lighting at Home and Abroad," by A. D. Charters. (At the Lecture Hall of the Midlands Electricity Board, 31, Kingsway, Stoke-on-Trent.) 6 p.m.

**October 14th**

MANCHESTER.—"The Social Significance of Lighting," by W. T. O'Dea. (At the Demonstration Theatre of the North Western Electricity Board, Town Hall, Manchester.) 6 p.m.

**October 19th**

GLOUCESTER AND CHELTENHAM.—Annual Dinner. (At the Belle Vue Hotel, Cheltenham.)

LIVERPOOL.—Chairman's Address, by G. W. A. Illingworth. (At the Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool.) 6.30 p.m.

**October 20th**

NORTH LANCASHIRE.—Presidential Address, by E. C. Lennox. (At the Demonstration Theatre of the North Western Electricity Board, 19, Friargate, Preston.) 7.15 p.m.

TEES-SIDE.—" Sports Lighting," by M. W. Peirce. (At the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough.) 6.30 p.m.

**October 22nd**

BATH AND BRISTOL.—" An Analytical Approach to Industrial Lighting," by W. Imrie Smith. (At The Royal Hotel, Bristol.) 6.15 p.m.

**October 25th**

LEEDS.—Chairman's Address, by J. R. Bardsley. President's Address, by E. C. Lennox. (At the E.L.M.A. Lighting Service Bureau, 24, Aire Street, Leeds, 1.) 6.15 p.m.

LEICESTER.—" Artificial Illumination of Horticultural Crops," by A. Calvert. (At the Demonstration Theatre of the East Midlands Electricity Board, Charles Street, Leicester.) 6 p.m.

**October 29th**

BIRMINGHAM.—" Teaching Illuminating Engineering." (Joint meeting with the I.E.E. Education Discussion Circle at James Watt Memorial Institute, Gt. Charles Street.) 6.30 p.m.

## Trade Literature

DYNALITE ELECTRICAL, 38, Stevedale Road, Welling, Kent.—Leaflet describing complete kits (known as Dynalite Kits), comprising of instant start fluorescent lamp, ballast and lamp holders. The idea of the kits is to enable householders to install fluorescent lighting at a minimum cost.

SMART AND BROWN (ENGINEERS), LTD., 8, Rose and Crown Yard, King Street, St. James's, London, S.W.1.—Brochure illustrating industrial luminaires and the " Maxilite " matched luminaires. Obtainable from all branches.

PHILIPS ELECTRICAL, LTD., Century House, Shaftesbury Avenue, London, W.C.2.—Booklet entitled " Perfection in a Flash," which contains extensive technical informtion on the use of " Photoflux " flash bulbs, including revised time and light specifications for both monochrome and colour photography.

CRYSELCO, LTD., Kempston Works, Bedford.—Brochure of Industrial Lighting Fittings giving details and illustrations, together with price lists.

METROPOLITAN-VICKERS ELECTRICAL CO., LTD.—New edition of the Lamp Catalogue with many additional interesting facts on electric lamps chosen to help the user and reseller to answer queries. Well illustrated with full details and prices.

METAL SECTIONS, LTD., Oldbury, Birmingham.—Illustrated brochure giving details of " Difulite," an entirely new architectural and constructional approach to modern interior decoration and ceiling lighting.

## Capital Wanted

Well established neon sign firm, own glass shop, wants £5,000 capital for Preference shares, profit participating, units not less than £250. References exchanged. Write Box No. 864.

## Trade Notes

BENJAMIN ELECTRIC, LTD., announce a new finish to their luminaires known as " Peropal." This finish is achieved by a new technique of high temperature stove-enamelling, embodying a synthetic resin providing the maximum protection and durability. The new range has been specially developed for light industrial needs and those departments of factories where the conditions are reasonably clean and dry. Benjamin, however, emphasise that when conditions are in any way more severe luminaires finished with " Crysteel " vitreous enamel should be used.

P. W. ALLEN & Co. have issued a leaflet giving full details of the " Allen Mobile Surgical Lamp," which has been specially designed for use in hospitals, clinics, works

*Allen Mobile Surgical Lamp.*

surgeries and nursing homes where a mobile intensity shadowless light is required for observation or minor operative work.

THE G.E.C., LTD., began to market Osram 40-watt and 60-watt G.L.S. lamps in the same bulb size last year. A further stage in the simplification of the range of Osram G.L.S. bulb sizes came into effect from September 1, 1954, from which date 75-watt and 100-watt single coil and coiled coil lamps are supplied in a 68-mm. diameter bulb for all three types (clear, pearl and silverlight). The reduction in bulb diameter for the 100-watt lamp makes possible the adoption of smaller cartons for this rating, with a consequent saving in space on distributors' shelves.

THE BRITISH THOMSON-HOUSTON CO., LTD., announce a price reduction in their single-lamp " Perspex " fluorescent reflector fittings as from September 1. The " Mazda " series F1160 (open end) and F1162 (closed end) industrial reflector fittings will now sell at £8 9s. (no Purchase Tax). Both incorporate fixed B.C. lampholders, and the new B.T.H. " Pendicone " suspension system for rapid installation and maintenance.

E. J. DAWES, LTD., announce the introduction of a fluorescent lamp starter designed, by the incorporation of a small thermal switch, to cut out the glow switch and lamp filaments when the lamp fails to strike. This avoids damage to the starter switch by repeated attempts to strike a lamp which has reached the end of its useful life.

# POSTSCRIPT By "Lumeritas"

As many readers will know, the British Association for the Advancement of Science recently held its annual meeting at Oxford; and, because it was televised as well as broadcast by radio, many will have heard the fine address of the president, Dr. E. D. Adrian, O.M. The theme of the address, "Science and Human Nature," was well chosen, for so great has been advancement in the natural sciences that it has led to developments which should make us realise how important it now is to obtain "more insight into human behaviour"—to achieve more advancement in the social sciences. The study of human behaviour and human relations is, of course, by no means important only for what help it may give to great communities in avoiding the most disastrous of follies, and in the practice of "peaceful co-existence." Obviously it is relevant in every field of human endeavour—even in "illuminating engineering." Three months ago I referred, incidentally, to the Hawthorne experiments. They were made about 30 years ago in a large industrial plant where there was a good deal of worker dissatisfaction. In the first place, the effects of changing the working illumination were studied. It was found that increasing the illumination led to an improvement in output of the experimental group of workers but, surprisingly, the output of a control group whose illumination had not been changed improved at the same time. The illumination for the test group was then reduced, and again their output improved. Clearly, then, even if the higher illumination was enjoyed by the workers it was not, by its own virtue, the cause of better working. Subsequent experimental changes of other working conditions, and then reversion to the original conditions, gave similar results. It was concluded that the really potent change was the change in human relations between management and workers—a change due to the interest in the workers evinced by the management as expressed by institution of the experiments. The lesson to be learned from these experiments is not only that good will is what is always needed anyway and what is, sometimes, the whole real "essence of the matter," but that an improvement in lighting can be one of the ways of establishing this good will. On the other hand, even in connection with changes of lighting, faulty human relations cannot merely inhibit any potential favourable effects, but can make it appear that the altered lighting has definitely harmful effects. Such cases are within my own experience, but I will only mention an example reported not long ago by the medical officer to one of the largest private enterprise employers in this country. One of the firm's drawing-offices was relighted to a considerably better standard by installing fluorescent lighting in place of the original tungsten system. Within a short time many of the occupants complained of a variety of symptoms attributed to eyestrain, and, eventually, they informed the management that they could not continue their work with the new lighting. But there was nothing about the lighting itself which could reasonably be held to account for the symptoms complained of. Tactful discussion with the disaffected persons disclosed that they felt aggrieved because they were not consulted before the change of lighting was made, and that there were other difficulties, due to faulty leadership of the group, for which the fluorescent lighting was being made the scapegoat. Complaints of eyestrain ceased after removal of these difficulties.

Mention of fluorescent lighting reminds me of a leaflet, recently brought to my notice, which advertises fluorescent lighting "kits" for the benefit of the "handyman" who may have the urge, or can be prompted to have the urge, to modernise his home lighting. It is the production of a native supplier, although the photographic illustrations of the domestic lighting schemes the handyman can contrive with the aid of the kit are all by courtesy of the American Illuminating Engineering Society. We are living in a "kit" age—there are rug-making kits, furniture kits, radio and television kits, and so on. So we must not be surprised at the advent of a fluorescent lighting kit. It all reminds me of a psychological thesis I happened to read a good many years ago, to the effect that "everything is applied to whatever it is applicable to"!

Apropos home lighting, the London "Daily Telegraph" published an article last month on new domestic lighting fittings but, in addition, offered a prize of £5 for the most interesting letter briefly describing the writer's ideas about the cheerful and efficient lighting of rooms. Other writers whose letters might be chosen for publication were to receive one guinea each. The instigator of this competition expressed the opinion that "a civilised home should have an artificial lighting service which switches on all over the house as evening falls," although she added, "no doubt this is fanciful and would cost too much." However, the offer of £5 for stating "their views of what would constitute the perfect lighting of a room" may induce some of the general public to give the subject of home lighting more thought than it would otherwise command.

I am indebted to Dr. J. W. T. Walsh for the following short account of an interesting "lighting event." "The town of Springe, not far from Hanover, has lately been celebrating the hundredth anniversary of the invention by Heinrich Goebel of a practical electric lamp. Goebel was born in Springe in 1818. He emigrated to America in 1848 and lived in New York, where he carried out experiments on the use of an electrically heated carbon filament as a source of light. It is related that in 1854 he not only illuminated his shop window with lamps of his own making, but he also drove along the streets of New York a carriage illuminated in the same way, the supply for the lamps being derived from primary cells. The celebrations lasted a week and centred round a commemorative obelisk erected to mark the centenary and surmounted by a 16-ft.-diameter outline of a lamp in luminous tubing; choirs chanted a 'Hymn to Light,' and Prof. Helwig gave an address. Later there was a pageant with scenes from Goebel's life." I must confess I was previously ignorant of Goebel as an electric lamp pioneer. The names Swan and Edison are better known in this connection, and a "Jubilee of Lighting" is going on in the United States to mark the seventy-fifth anniversary of Edison's invention of a carbon filament electric lamp.

s

g
r

:,
it
o
:,
of
s
i-
e
e
i-
e
t-
o-
at

e-
ic
25
's
s.
a-
of
ed
ch
gh
oo
ws
n"
ect
ise

ng
he
en
by
oel
ica
ex-
on
354
of
of
the
ells.
om-
and
in
and
ant
was
eer.
this
n in
y of